GENESIS SEARCH FOR ORIGINS Education

Destination L1: A Thematic Unit

Round and Round

STUDENT ACTIVITY

BACKGROUND INFORMATION


NASA

The planets travel around the sun in a path called an orbit. Nicolaus Copernicus (1473-1543) is given credit for first recognizing the sun-centered system of planets that we call the solar system. He stated that all the heavenly spheres revolve around the sun, with the sun at the center of the cosmos. Tycho Brahe (1546-1601) rejected the Copernican sun-centered universe based on his observations. He developed a model in which the sun and the moon orbited the Earth, but the stars orbited the sun. Brahe invented instruments that allowed him to determine the detailed motions of the planets. Johannes Kepler (1571-1630) was Brahe's assistant. He was given the task of understanding the orbit of Mars. It was with Tycho Brahe’s data that Kepler was able to form ideas about the motion of the planets that we still work with today.

In this activity you will learn about Kepler’s First Law of Planetary Motion by participating in three discovery activities. Before Kepler, it was thought that the orbits of the planets were all circular.

PROCEDURE (Part One):

“Shadow Dancing”

1. Obtain the materials from your teacher. Using the light bulb and the jar lid, make the shadow of the jar lid appear on the graph grid below. Trace how it appears below and describe its shape. Measure and record the diameter, radius, circumference, and area of this shape.

Circumference ______________ Area _____________Diameter _____________Radius_____________

Description of traced object:

2. Repeat Part One, but this time tilt the lid. Describe how the shadow changed. Trace this new shape. Measure and record the circumference and area of this shape.

Circumference ______________ Area _____________

Description of traced object:

3. You have just discovered part of Kepler's First Law of Planetary Motion. It refers to your second tracing. This is a physical model of a planet's trip around the sun. But, there is more! Write down what you think Kepler's First Law states in the space below.

PROCEDURE (Part Two):

"Strings and Pins"
In this activity you will construct an ellipse by using strings and pushpins.

1. Obtain materials from your teacher. Secure the paper to the styrofoam sheet with four pushpins.
2. Place the other two pushpins 10 centimeters apart on the middle of the paper.
3. Make a 15-centimeter loop with your string.
4. Loop the string over the two pushpins in the middle of the paper.
5. Using a pencil, form a triangle with the string, keeping it tight.
6. Allowing no slack, draw an ellipse on your paper.
7. Remove the string and two pushpins in the center of the paper.
8. Each hole is called a **focus** of the ellipse. Choose one and label it "sun."
9. Somewhere on the ellipse, put a dot and label it "planet."
10. Based on what you have done so far in this activity, write your definition of Kepler's First Law of Planetary Motion in the space below.

11. Along the planet's orbit, find the place where the planet is closest to the sun. This is called "**perihelion**." Label this location "P."
12. Along the planet's orbit, find the place where the planet is farthest from the sun. This is called "**aphelion**." Label this location "A."
13. Find the point that is halfway between the two foci and make an "X."
14. Draw a straight line from the "X" to the sun. Label this line "c."
15. Draw another straight line from the "X" through a focus until you intersect the ellipse. This line is similar to the radius of a circle, but with an ellipse it is called the "**semi-major axis**." Label this line "a."
16. Mathematicians use the word "**eccentricity**" to measure the flatness of an ellipse. Eccentricity of an ellipse can be found if one knows the semi-major axis (a) and the distance from the center of ellipse to one of the foci (c). Use the following equation to find the eccentricity of the ellipse that you drew. Use the space below to show your work.

    Eccentricity = c/a

PROCEDURE (Part Three):

"Eccentricity of the Planet's Orbits"

1. Using the formula e = c/a, find the eccentricity of each of the planets by filling in the chart below:

Planet	Distance from center of ellipse to focus in Astronomical Units (c)	Semi-major Axis in Astronomical Units (a)	Eccentricity (e)
Mercury	0.080	0.387	
Venus	0.005	0.723	
Earth	0.017	1.000	
Mars	0.142	1.524	
Jupiter	0.250	5.203	
Saturn	0.534	9.540	
Uranus	0.901	19.180	
Neptune	0.271	30.060	
Pluto	9.821	39.440	

2. Which planetary orbit is the most eccentric? What does this mean?

3. Which planetary orbit is the closest to being a circle?

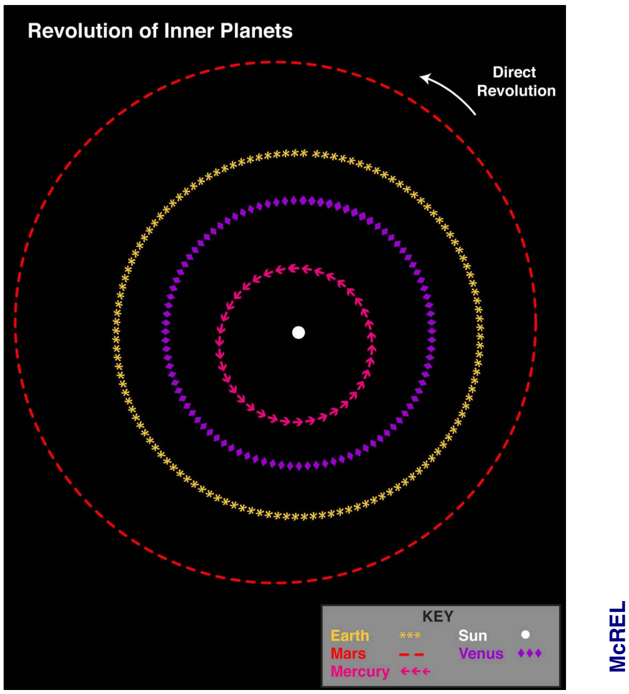
4. Which two orbits have the closest eccentricity?

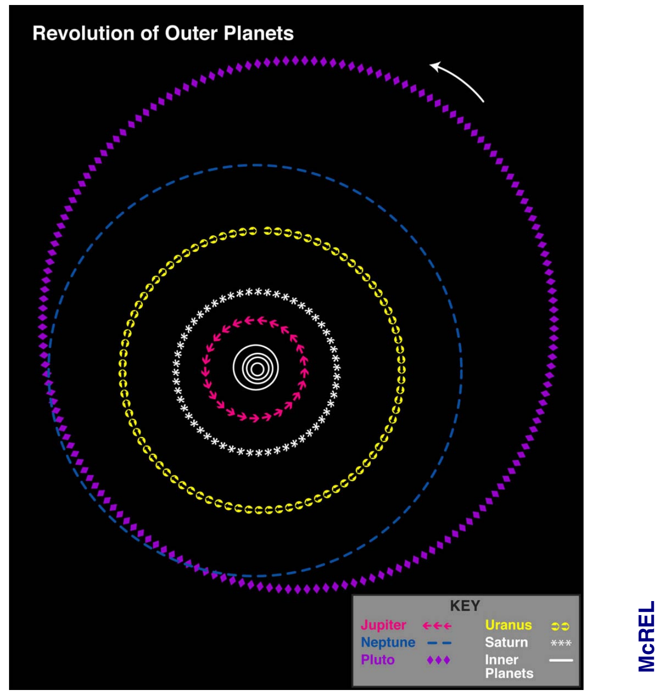
5. What other planet has an orbital eccentricity most similar to the Earth's?

PROCEDURE (Part Four):

"Here's Looking at You"

1. Observe the following orbital diagrams of the planets. Describe the eccentricity of the orbits in your own words.





2. Describe Kepler's First Law of Planetary Motion in your own words.